

Business Experimentation and Causal Methods

Spring 2024

Instructor: Andrey Fradkin

Lecture 1: Introduction

Welcome! The goals for today are:

- Convince you that this class will be **interesting** and **impactful** for your career.
- Discuss the logistics of the class.

Causal claims are everywhere!

Joe Rogan, confined to Spotify, is losing influence

by Ashley Carman, theverge.com

August 25, 2021 08:30 AM



Photo by: Illustration Alex Castro / The Verge | Vivian Zink/NBCUniversal via Getty Images



Eight Self-Help Books That Actually Help

ELEANOR CUMMINS
8:00 AM ET

Tesla Stock Drops After Vehicle Delivery Falls Short

Shares were off 14%, making them the biggest decliner on the S&P 500. Tesla said Monday it delivered fewer vehicles than it initially targeted.

- **Heard on the Street: Sales Put Spotlight on Margins**

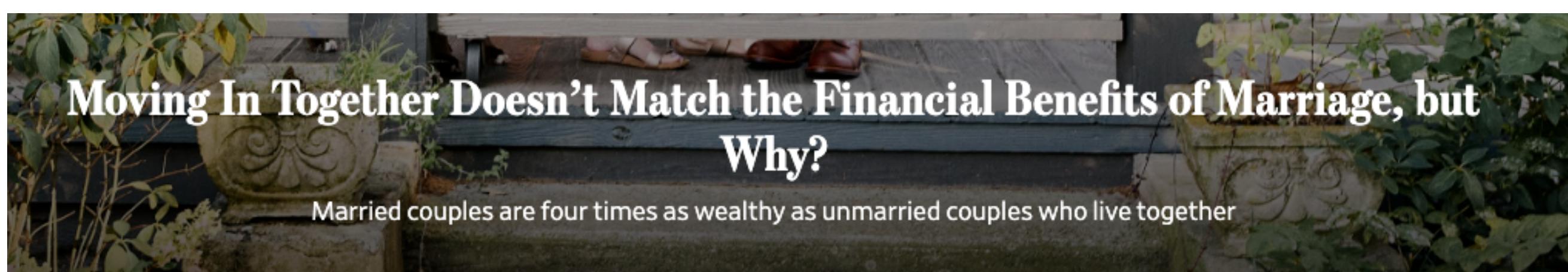
Why skyscrapers are so short

Words by Brian Potter

The height of skyscrapers is limited by physical, economic and regulatory barriers, but we should want to overcome them and build taller. Here's how we can do it.

[Read more →](#)

Economics



This class is about evaluating and measuring causal claims.

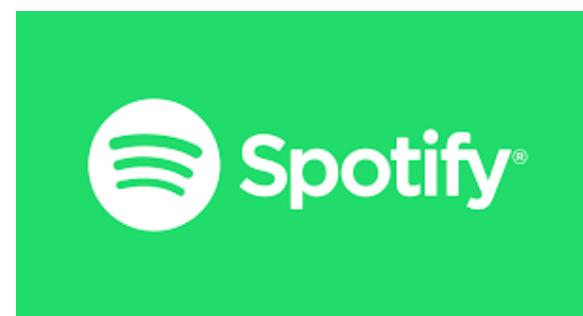
- A causal claim takes the following form.
 - If a treatment was given to a person (or group), they would have one outcome.
 - If instead, a different treatment would have been given, they would have another outcome.

World A

All platforms



World B



Important philosophical point

- We can never see for the same person and time what would happen if they were treated and if they were not treated.
- To do so, we would need a parallel universe.



Example of a causal question in business:

- What would happen to the profits of Starbucks if they raised the price of a latte?



Example of a causal question in business:

- What would happen to the profits of Starbucks if they raised the price of a latte?
- In this class, we want to make causal claims precise!
 - From what old price to what new price?
 - For what locations?
 - How are consumers informed of price change?



Can you come up with a causal question?

About Me

- Ph.D. in economics from Stanford.
- Data Scientist at Airbnb, worked with Meta, Indeed, Rover, Pinterest.
- Many (but not all) class examples from digital platforms:



Predicting the effects of a change is hard, let's try!

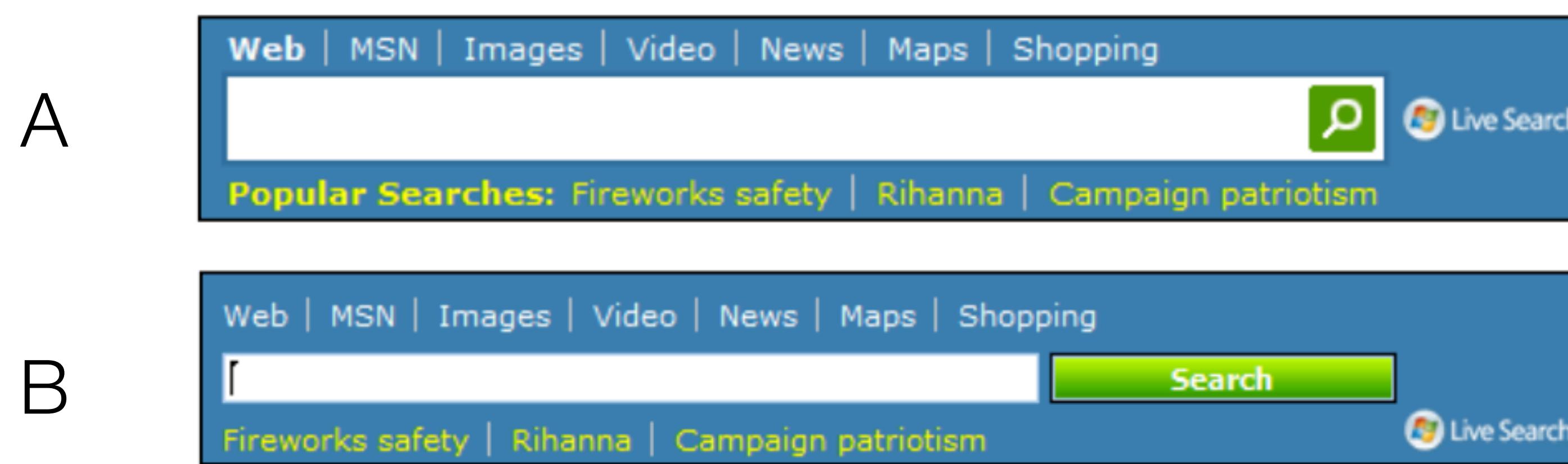
**Three experiments from Microsoft Bing, you have
to guess the result.**

Example 1: MSN Home Page Search Box



Overall Evaluation Criterion (OEC)?

Example 1: MSN Home Page Search Box



Overall Evaluation Criterion (OEC):
Clickthrough Rate for Search Box and Popular Searches

Which one is better?

A

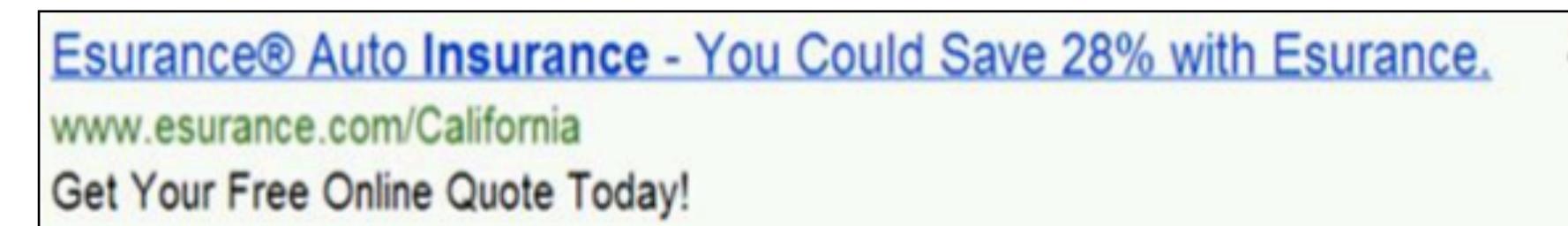
B

Same

Result: No Effect

Example 2: Bing Ads with Site Links

A



B



Overall Evaluation Criterion (OEC):
Revenue (constrained to same amount of page space)

Which one is better?

A

B

Same

Result: Millions of dollars in profit.

Example 3: Number of Search Results

A: 10 Results

B: 8 Results

Overall Evaluation Criterion:
Click rate on page.

Which one is better?

A

B

Same

The screenshot shows a Bing search results page for the query "kdd 2015". The results are as follows:

- KDD 2015, 10-13 August 2015, Sydney**
www.kdd.org/kdd2015 •
KDD 2015 is a premier conference that brings together researchers and practitioners from data mining, knowledge discovery, data analytics, and big data.
You've visited this page before - See search history
Research Track
KDD 2014, a premier interdisciplinary conference, brings together ...
Sponsorship
KDD 2015 will be held between 10-13 August 2015 in Sydney.
Attending
Attending KDD 2015 Visa Information; Registration.
Tutorials
KDD 2015 Call for Papers, Workshops, Tutorials and ...
Organisers
Organisers and programs committee members for KDD 2015
See results only from kdd.org
- KDD 2015 - The 21th ACM SIGKDD International Conference ...**
conference.researchbib.com/view/event/33616 •
KDD 2015 - The 21th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining
- KDD CUP 2015**
https://www.kddcup2015.com •
If you have any questions or comments, please send an email to support@kddcup2015.com. Updates: 1) Many people have asked the definition of ...
- KDD 2015 : ACM SIGKDD Conference on Knowledge Discovery ...**
nybuan.com/conference/136 •
The Latest Computer Conference and Journal List ... KDD 2015 : ACM SIGKDD Conference on Knowledge Discovery and Data Mining
- KDD 2015 -ACM SIGKDD International Conference on ...**
www.eureglocal.com/euregcp/?confid=37&year=2015 •
KDD 2015 -ACM SIGKDD International Conference on Knowledge Discovery and Data Mining. Send this CFP to us by mail: cfp@eureglocal.org. Introduction: SIGKDD aims to ...
- KDD-2015 Call for Papers, Workshop proposals - KDnuggets**
www.kdnuggets.com/2015/01/kdd-2015-call-papers.html •
ACM SIGKDD Conference on Knowledge Discovery and Data Mining(KDD) 2015 will be held in Sydney, Australia during August 10-13, 2015. KDD invites submissions of ...
- KDD 2015 | 21st ACM SIGKDD Conference on Knowledge ...**
eventbrite.com/kdd-2015 •
KDD 2015. 21st ACM SIGKDD Conference on Knowledge Discovery and Data Mining, Australia, Sydney, 10 - 13 August 2015
- KDD 2015 : 21th ACM SIGKDD Conference on Knowledge ...**
www.sigkdd.com/cfp/seventevent.showcfp?eventid=46581 •
KDD 2015 : 21th ACM SIGKDD Conference on Knowledge Discovery and Data Mining. Home, Login, Register, Account, Logout, Categories CFPs, Post a CFP, Conf ...

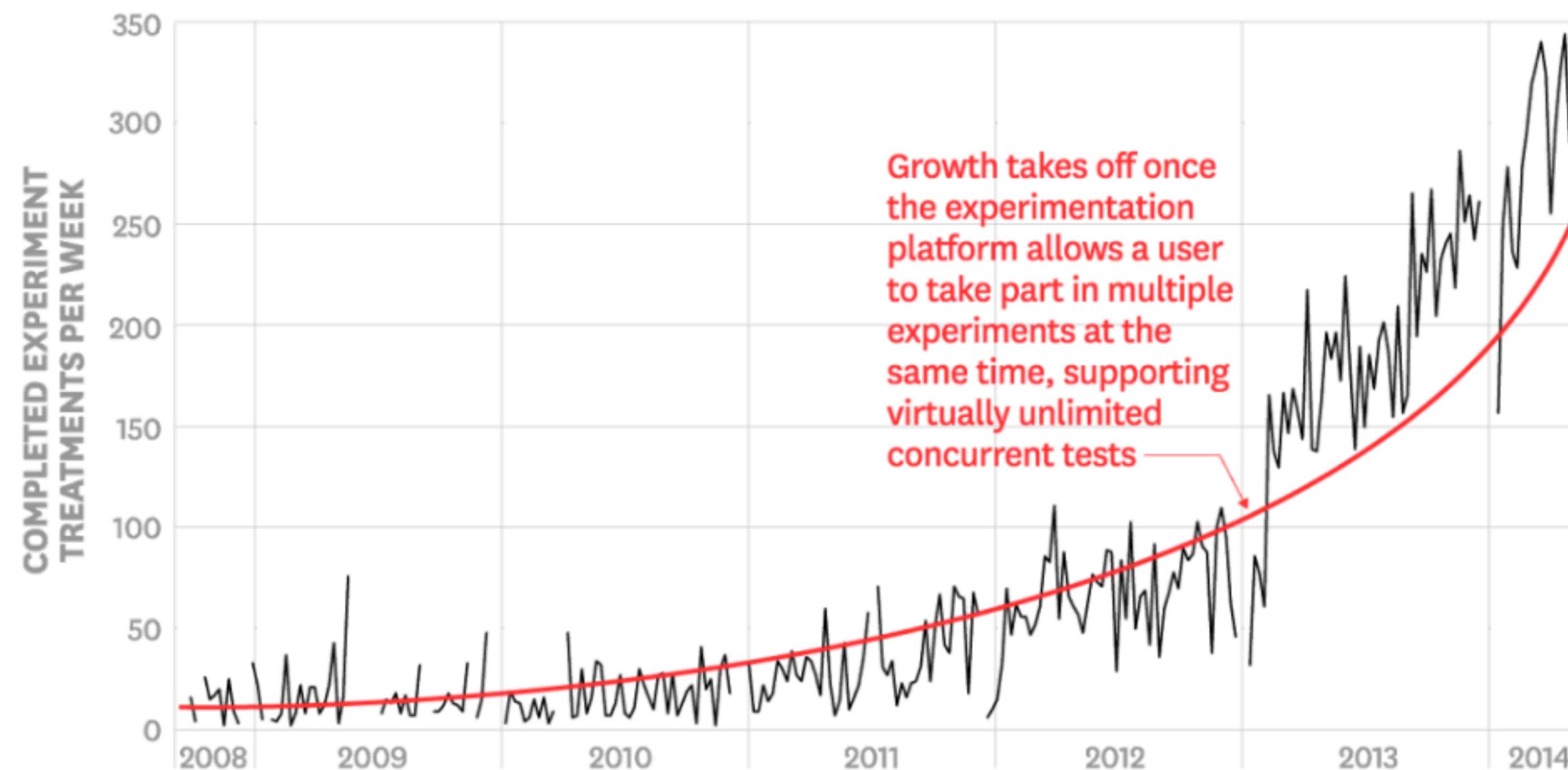
On the right side of the results, there's a sidebar with the following information:

- KDD 2015**
We invite submission of papers describing innovative research on all aspects of knowledge discovery and data mining, ranging from theoretical foundations to novel models and algorithms for data mining problems in science, business, medicine, and engineering. Visionary papers on new and emerging topics are also welcome, as are appl... +
wikiclp.com
- Dates: Aug 10 - 13, 2015
- Location: Sydney
- Subjects: Data mining · Database · Knowledge extraction
- Website: KDD 2015
- Submissions due: Feb 20, 2015
- People also search for:
ICDM 2015 (Nov 14, 2015)
CIKM 2015 (Oct 19, 2015)
ICML 2015 (Jul 06, 2015)
AAAI 2016 (Feb 12, 2016)
WWW 2015 (May 20, 2015)
See more ▾
- Data from: Wikiclp.com
Feedback
- Related searches:
KDD 2014
KDD 2016
WSOM 2015
PAKDD 2015
ICDM 2015
KDD Sydney
SIGR 2015
KDD Cup 2015

Result: No Effect!

Business experimentation has grown over the past 15 years

The Growth of Experimentation at Bing



FROM "THE SURPRISING POWER OF ONLINE EXPERIMENTS,"
SEPTEMBER-OCTOBER 2017, BY RON KOHAVI AND STEFAN THOMKE

© HBR.ORG

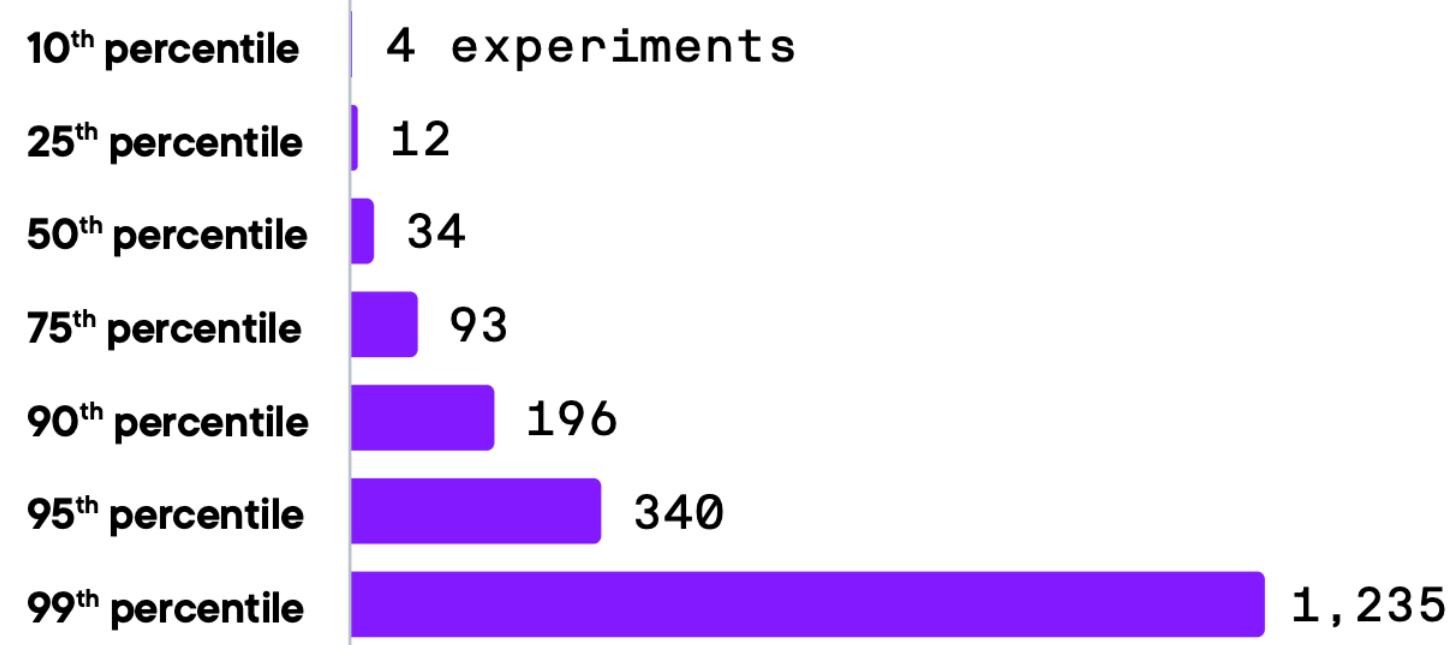
“Our success at Amazon is a function of how many experiments we do per year, per month, per week, per day.”

- Jeff Bezos

Data from Optimizely

**To be in the top 10%
of experiment velocity,
companies need to run
around 200 tests annually**

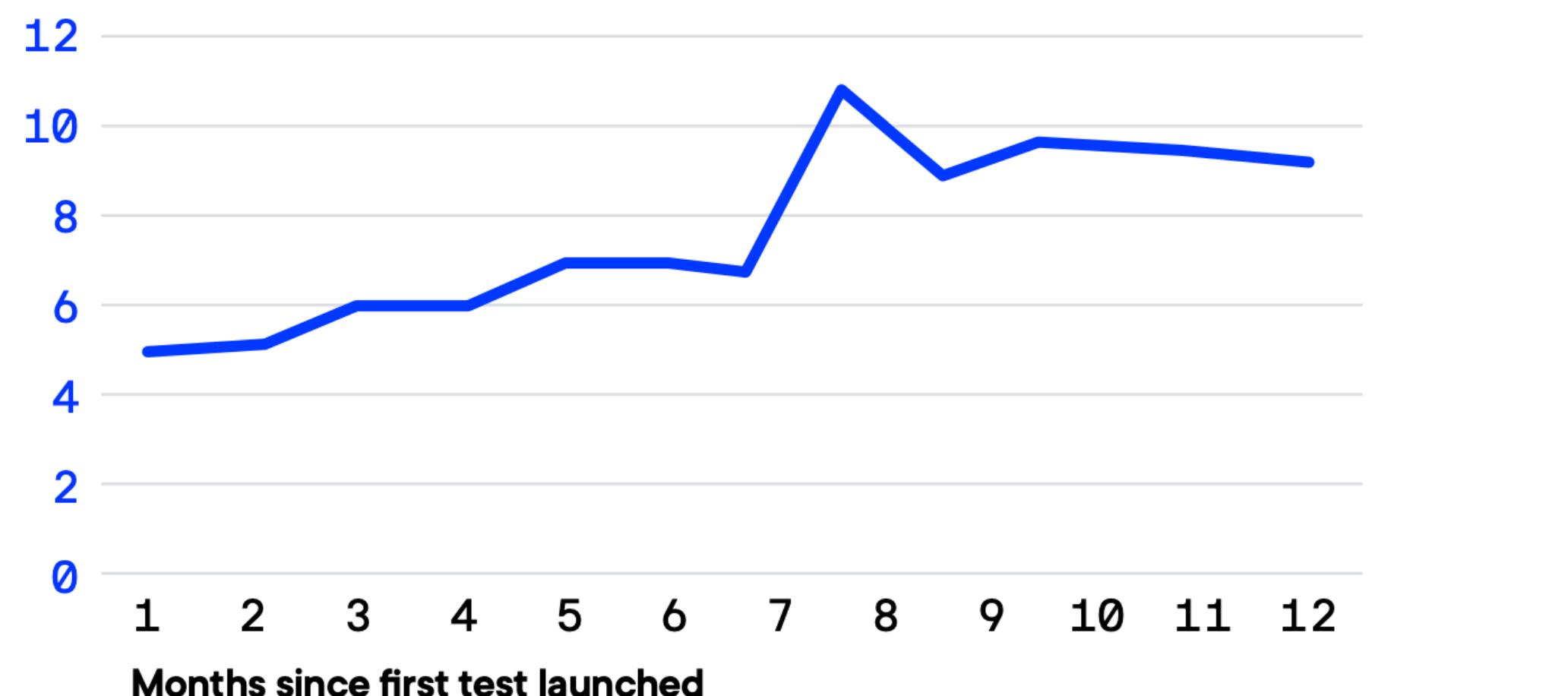
Experiment velocity by company
Experiments created in 2022, over 900 companies



- The median company runs around 3 experiments per month.
- Reaching the top 10% of velocity requires scaling to 16+ tests per month.
- Only 3% of companies are in the elusive 500 tests club.
- The top 1% run over 1,000 tests per year.

Experiments created per month from first test launch on Optimizely
116 companies creating their first experiment 1st December to 1st June 2022

Launched Experiments Per Month



Predicting impact without experiments is hard!

Why Randomize?

Randomization solves selection bias.

- It ensures that as the sample grows large, the only **relevant** difference between treatment and control groups is the treatment!

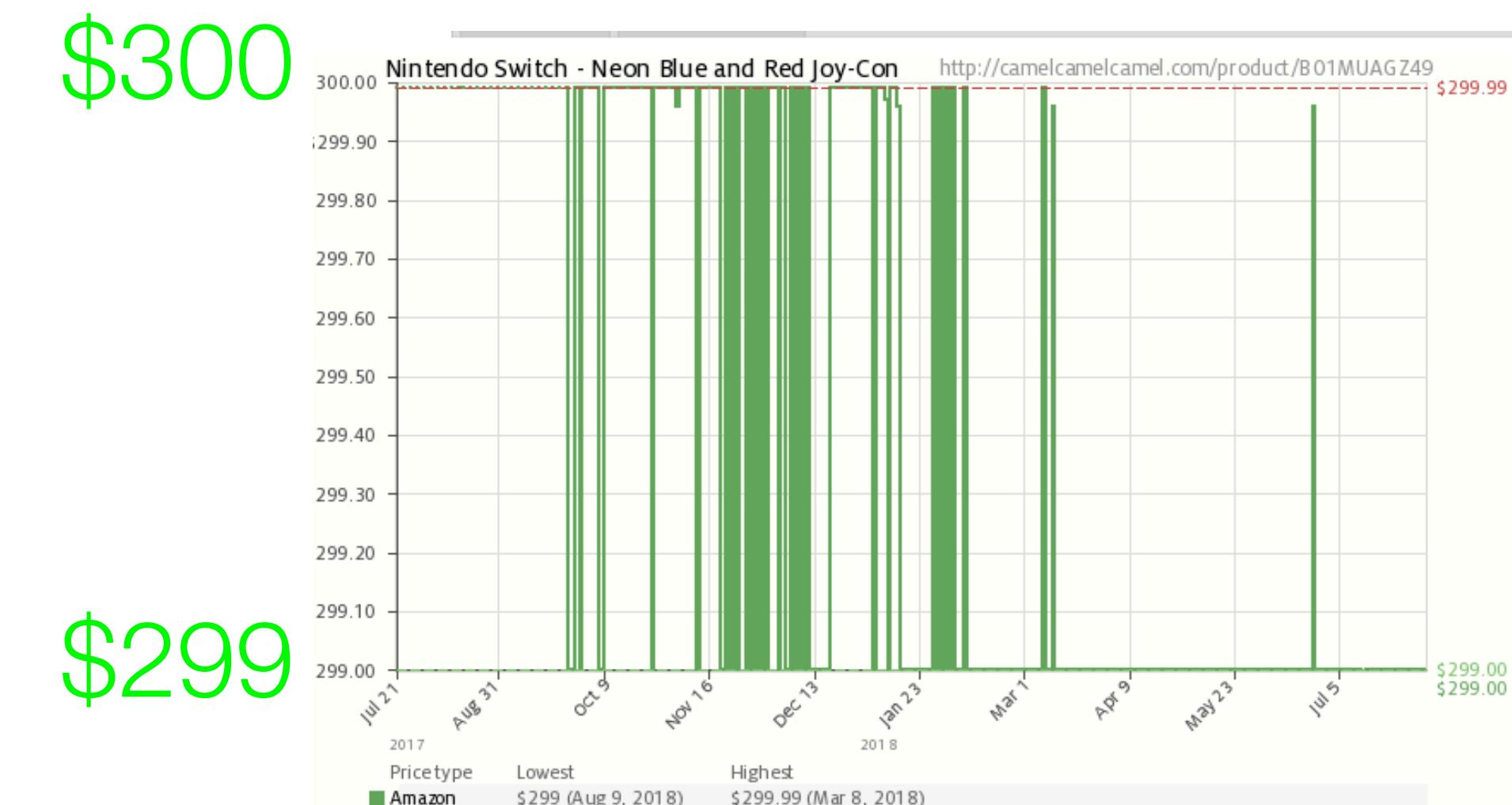
Selection bias

- Selection bias is any difference in outcomes between the treatment and control group **not caused by the treatment.**
- For example, if all of the treated people were old and all of the not treated people were young, their survival rates may be different because of age.
- Train you to recognize when selection bias may be present.

Another reason to experiment: the situation you are interested in has never occurred before!

Price of Nintendo Switch (1 year period)

A product whose price has never changed.



Causal Methods vs Machine Learning?

Machine Learning in 1 Slide

- Training Data: Pictures with muffins or dogs, with **labels**.
- Goal, predict if unlabeled images are muffins or dogs.
- **Simplified** version of what machine learning does:
 - Finds training data close to test.
 - Takes an average of muffin vs dog for similar training data.
 - That average is the prediction.



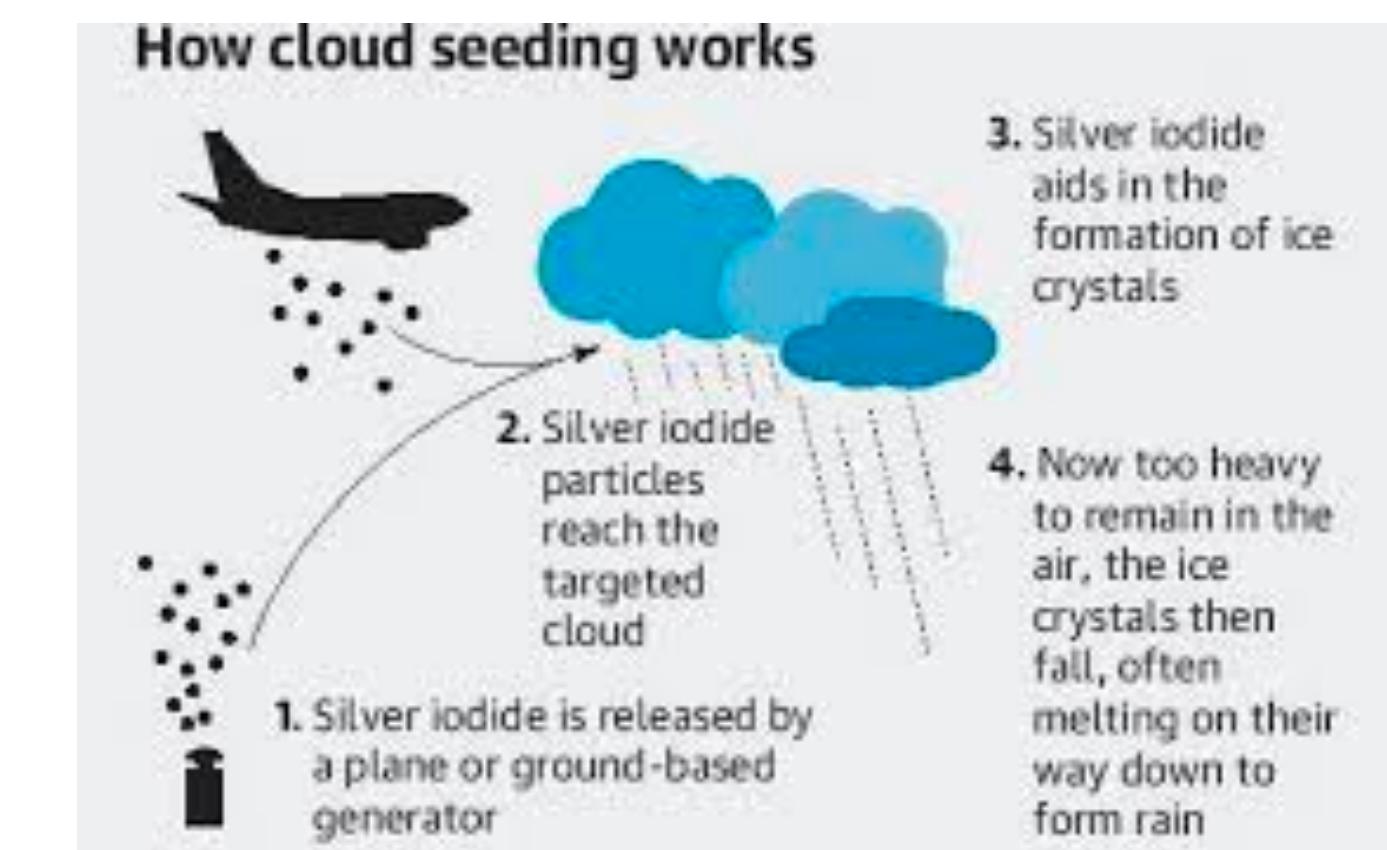
“Big Data” = More images.

- Can find closer matches for unlabeled data.
- Generally better prediction accuracy.



Prediction vs Causality

- We can use the machine learning prediction to decide if we need to bring an umbrella!
- Harder to use machine learning to tell us how to create the rain!
- Can use experiments to study if cloud seeding works.



Programming in this
class!

Github Codespaces

- Github Codespaces are an easy and self-contained way to code.
- You can choose to use your local machine, but we can provide less support with that.
- We will primarily use Jupyter Notebooks, accessed from Github Codespaces, for assignments and analysis.

Our contract:

- I will do my best to help you learn and use Python.
- You must be enthusiastic about learning and using Python!
- In the beginning of class, there is a lot of syntax to learn. This may feel overwhelming but you'll get the hang of it.

A note on math.

- This class has some math but it is not a math class.
 - Mathematical notation is very useful in stating what assumptions an analysis makes.
 - This class will **not** focus on the technical details of these statistical procedures
 - More technical and less practical treatment in stats and economics departments, see me if interested.

Course Logistics

Syllabus is on Notion (link is available on Blackboard / Github).

BA472 Syllabus and Course Resources (2024)

Business Analytics 472 - Business Experimentation and Causal Methods

Instructor: Professor Andrey Fradkin
Office: Zoom or Questrom 617
Office hours: <https://calendly.com/afradkin/15min>
Zoom link for office hours:
<https://bostonu.zoom.us/my/afradkin>
Email: fradkin@bu.edu

Meeting Times: 4:30 - 5:45
M/W
In-Person Room: HAR 312

TA Office Hours:
Head TA:
Liyan Wang (lyanwong@bu.edu)
+ Friday (10am, room 427 Questrom)

TA: Chandrahas Aroori (charoori@bu.edu)
Monday 1pm (Zoom)

TA: Tamanna Jain (tamannaj@bu.edu)
1pm Friday
<https://bostonu.zoom.us/my/tamannajain>

Key Links:

- [Schedule](#)
- [Slack](#) (for course discussion and communication)
- [Questrom Tools / Blackboard](#)
- [Guide to Github Codespaces](#)
- [Course Pack](#)
- [Gradescope](#) (for submitting assignments):
 - Entry code: **8EZYR5**

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Role of in-class time

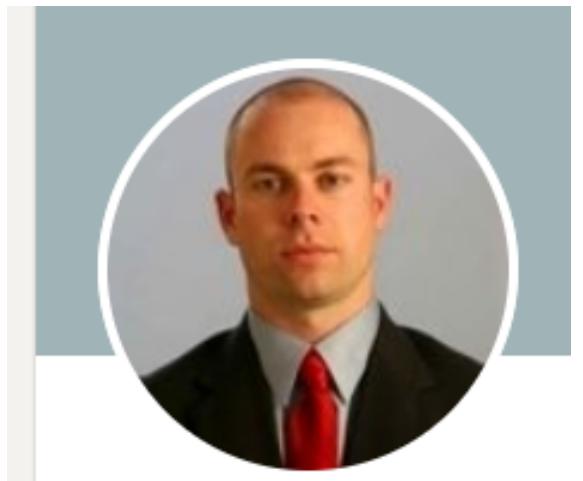
- Class is for the following activities:
 - Lectures.
 - Group discussions and small lessons to reinforce materials.
 - Working on assignments and group project.
 - Guest Lectures.
 - Doing cases - often the session after the assignment is due.
 - Asking me questions.
 - 1 Exam.

To see what we're doing in class, check the syllabus!

Dates	Type	Description	Assignments Due	TODO Before Class
January 22, 2024	Session	Introduction to Business Experiments, Course Logistics		
January 24, 2024	Session	Nudge Case		Watch Potential Outcomes Lectures, Read Nudge Case, Write letter
January 29, 2024	Session	Python practice, start on assignment		Intro to Coding Lecture
January 31, 2024	Session	Discuss Assignment / Plots, Stats Refresher and Randomization	Assignment 1 Due	Watch lecture on statistics refresher and randomization
February 5, 2024	Session	Continue stats Refresher and Randomization + Measuring Uncertainty		
February 7, 2024	Session	ROI, Ad Experiments + In Class Exercise		
February 12, 2024	Session	Work on Assignment		
February 14, 2024	Session	Case: RocketFuel	Assignment 2 Due	Watch Lectures on Regression and Experiments
February 21, 2024	Session	Designing an experiment		Watch Lectures on Analyzing an Experiment
February 26, 2024	Session	Regression, continue working on the problem set		
February 28, 2024	Session	Case: Stubhub	Assignment 3 Due	

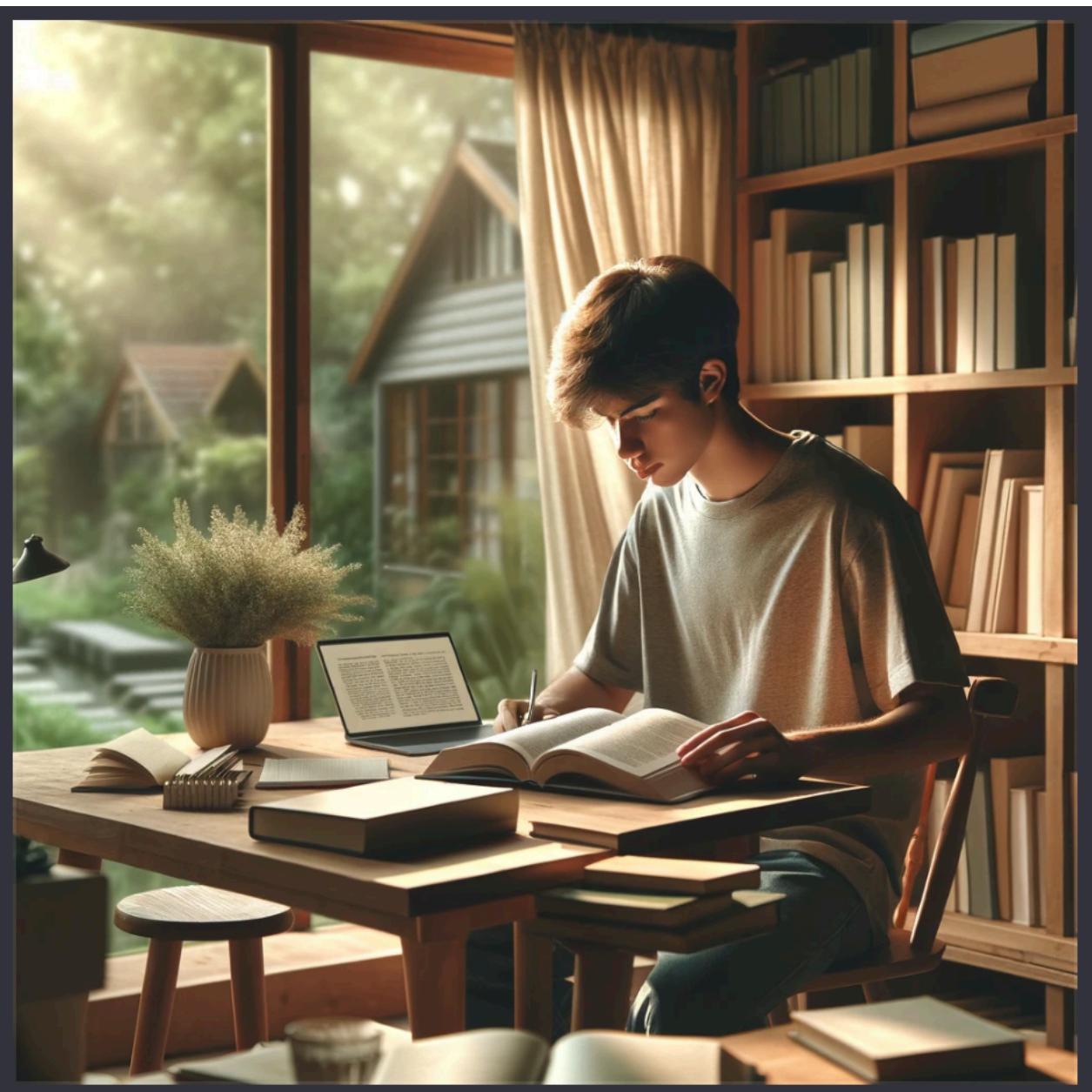
Three awesome guest lectures lined up:

- Peter Coles, Head Economist for Policy (Airbnb)
- Lucas Puente, Senior Director, Survey Science and Quantitative Research (Slack)
- Dmitriy Masterov (Data Science Consulting, ex-Thumbtack / Ebay)



Role of non-class time

- Read course materials:
 - Python notes
 - Causal inference notes
 - Cases
- Occasional video lecture
- Finish up parts of assignment not done in class.
- Work on final project.



Course communication:

- Please use Slack.
- Post general questions in the channel.
- Ask specific questions about assignments / course organization to the TAs, who can then forward them to me.
- Questions about life, overall course progress, etc... Direct to me.

Office Hours:

- TA office hours in syllabus. Can contact them for additional time.
- I will also have office hours, please book those via the calendly link.

Instructor: Professor Andrey Fradkin

Office: [Questrom 617, Zoom](#)

Office hours:

YOU MUST BOOK BEFOREHAND AT THIS

LINK:

<https://calendly.com/afradkin/15min>

Typical availability:

TBD

Zoom link for Prof. Fradkin's office hours:

<https://bostonu.zoom.us/my/afradkin>

TA Office Hours:

Head TA: [Liyan Wang \(lwanwong@bu.edu\)](#)

Friday (10am, room 427 [Questrom](#))

Press 'space' for AI, '/' for commands...

TA: [Chandrahas Aroori \(charoori@bu.edu\)](#)

Monday 2pm (Zoom)

TA: [Tamanna Jain \(tamannaj@bu.edu\)](#)

1pm Friday

<https://bostonu.zoom.us/my/tamannajain>

Course Resources

- Python and Github guides are linked to from the syllabus and Github.
- Causal inference notes on Github.
- HBS Course Pack - Please purchase.
- Additional textbooks listed in the syllabus.

Course Materials

Course Pack

I will distribute recorded lectures, notes, slides, and articles as needed throughout the class. We will also be doing several cases, which you must purchase from the Harvard Business School course pack (see link at the top of this document).

Texts

There is no required textbook for this class. I'll provide written notes on the class materials. There are some optional texts you may look at if you'd like:



Optional reading:

- The Effect:

The Effect: An Introduction to Research Design and Causality | The Effect

The Effect: An Introduction to Research Design and Causality | The Effect is a textbook that covers the basics and concepts of research design, especially as applied to causal inference from observational data.

<https://theeffectbook.net/>

- Field Experiments by Gerber and Green.

This book focuses on running and analyzing field experiments in political science and economics. It has clear examples and explanations of the potential outcomes framework.

- Mastering Metrics: The Path From Cause to Effect by Angrist and Pischke.

This book has a more regression based take on causality but is still very accessible for those without a math background.

- Data Analysis for Business, Economics, and Policy has many code examples.

The screenshot shows the homepage of the website for 'Data Analysis for Business, Economics, and Policy' by Gábor Békés and Gábor Kézdi. The header includes navigation links for 'Gabor's Data Analysis', 'Case Studies', 'Data and Code', a search icon, and a menu icon. Below the header, there is a profile section for Gábor Békés and Gábor Kézdi, both from CEU and U Michigan, with a 'Follow' button. A 'Toggle menu +' button is located below the profile. The main title 'Data Analysis for Business, Economics, and Policy' is prominently displayed in a large, bold font. At the bottom of the page, there is a dark footer bar with small text and logos.

Grading

+ :: 🏆 **Grading**

Default view

Grade Breakdown

Aa Type	# Percent	≡ Group Size	+	-
📄 Participation (including cases)	15%	Individual		
📄 Assignments (Graded for completion)	30%	Individual		
Midterm	25%	Individual		
📄 Final Project	30%	Groups of 4 - 5		

+ New

COUNT 4

Participation

- Very important to practice for interviews + being effective in an organization.
- Biggest failure modes of data scientists:
 - Not understanding project requirements and working on something useless due to bad communication.
 - Failing to convince others their work is useful.

Participation

- Especially important: Class participation during cases. TA will be in the room to track participation.
- Participate during other times too.
- Ask questions and answer questions on **Slack**.
- On-time attendance!
- Work productively during in class exercises.

Assignments

- Mix of conceptual and data analysis questions. Goal is to be short and focused.
- You can ask others for help, but you **must** acknowledge them when you hand in an assignment and you must write your own assignment.
- Due date is on the syllabus and in the assignment.
- Submit on Gradescope.
- Grading based on a check +, check, no credit system.

ChatGPT

- In the real world, you will use chatGPT to code. As a result, I will not ban the use of chatGPT on assignments. That said, chatGPT can be very wrong!
- You will not be able to use chatGPT on the exam, in case discussions, or in class exercises.

: You may use one or more generative AI tools for the following assignments: homework assignments and final project. In each case, you are required to provide appropriate acknowledgment of the AI tools. This specific approval is given to allow you to become familiar with AI tools, to increase your AI literacy, and to understand how to use AI in appropriate ways within an academic context.

You may not use generative AI tools during the case discussions, in class exercises, and exam.

You may not use generative AI to answer my questions during class time.

Exam

- Goal is to make sure you know the basics of experimentation.
- Important to know this material to do a good job in designing the experiment for your final project.
- Will be done on paper, with 1 page of notes you can bring to class.
- March 27

Final Project (More details later!)

- Groups of 4 - 5 people.
- Run an experiment!
- The experiment should involve you gathering data about the impact of an intervention that you randomize. It should not involve pre-existing data.
- Write about the limitations of the approach.
- Present the project and write it up.

Examples from last year

- Does having your camera on Zoom affect your learning performance?
- Does putting your phone away while completing a task decrease distractions?
- Do people retain knowledge better from reading, listening, or watching (or watching at 1.5x) based on the same content?
- Does having a group of people in a photo of a tourist destination make respondents more or less interested in going there?

Let me know how I'm doing!

- I want to help you by improving my teaching. I can't know how well I'm doing unless you tell me.
- Contact me with suggestions: fradkin@bu.edu
- Office hours:
 - <https://calendly.com/afradkin/15min>
 - Please ask class related questions on Slack **first!**
 - If these don't work for you, just tell me.

For next class:

- Watch the Potential Outcomes Lecture on Youtube.
 - <https://youtu.be/HGPUevLRogQ>
- Read the HBS Case about Nudges.
- **Write a new tax letter that HMRC could use and be prepared to discuss.**

Recap:

- Measuring impact is critical for making good decisions.
- Randomization and deliberate intervention allows us to learn impact.
- This class how to run and analyze experiments to learn impact (causal effects).